REMARKS

This is in response to the Final Office Action mailed on February 3, 2010, in which the following rejections were made under 35 U.S.C. § 103(a):

1. Claims 1-3, 8, 10, 11, 16, 18, 19, 21, 22, 27, 28, 33, 43-45, and 47-49 were rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump, U.S. Patent No. 5,121,329 ("Crump") in view of Joseph et al., U.S. Patent No. 3,807,054 ("Joseph") or Edmonds, U.S. Patent No. 5,448,838 ("Edmonds"), and optionally, Batchelder, U.S. Patent No. 5,652,925 ("Batchelder");
2. Claims 4, 5, 23, and 46 rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Dahlin et al., U.S. Patent No. 6,022,207 ("Dahlin");
3. Claim 20 was rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Leyden et al., U.S. Patent No. 5,143,663 ("Leyden"); and
4. Claims 18 and 48 were rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Gessner, U.S. Patent No. 4,983,223 ("Gessner").

With this response, the specification is amended, claims 1, 21, and 43 are amended, and claims 16, 19, and 44 are canceled, such that pending claims 1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49 are presented for reconsideration and allowance.

I. Examiner Interview Summary

A telephone Examiner Interview was conducted on April 29, 2010 between Examiner John L. Goff and Brian R. Morrison (attorney for Applicants). Applicants initially wish to express their gratitude to Examiner Goff for taking time to discuss the case. During the Examiner Interview, the participants discussed the Office Action rejections and the enclosed

amendments to the claims.

II. Resubmission of the Zinniel Declaration

The Declaration of Robert L. Zinniel ("Zinniel Declaration") electronically filed with the November 18, 2009 Amendment, contained high-quality, black-and-white photographic images of test results (see Zinniel Declaration, Appendices A-1 – A-5). However, a review of the Image File Wrapper of the present application on the U.S. Patent and Trademark Office's Public PAIR website shows that the quality of the photographic images have been substantially reduced. Applicants believe this reduction in image quality is due to a file modification by the U.S. Patent and Trademark Office's electronic filing system.

As such, Applicants resubmit the same document for the Zinniel Declaration that was submitted with the November 18, 2009 Amendment in an attempt to provide high-quality photographic images for Appendices A-1 – A-5. In the event this subsequent submission also ends up with reduced-quality photographic images for Appendices A-1 – A-5, such that the Examiner believes that the demonstration discussed in the Zinniel Declaration is not adequately shown in the photographic images, Applicants respectfully request permission from the Examiner to submit full color versions of the photographic images for Appendices A-1 – A-5. The high-quality photographic images for Appendices A-1 – A-5 were also included in the originally signed version of the Zinniel Declaration.

III. Response to Obviousness Rejections

The Office Action indicated that claims 1-5, 8, 10, 11, 16, 18-23, 27, 28, 33, 43-49 were rejected under 35 U.S.C. § 103(a) in view of the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph/Edmonds, Dahlin, Leyden, and/or Gessner. With this response, Applicants amend claim 1 to recite wherein ~~at least a portion of~~ the object surface has at least one surface effect due to the fused deposition modeling technique. This amendment is presented for consistency with the subsequent phrase "wherein the at least one surface effect extends substantially across an entirety of the object surface", and is not intended to affect the scope of claim 1.

Applicants also amend claims 1, 21, and 43 to include the elements of claims 16, 19,

and 44, such that claims 1, 21, and 43 recite reflowing the softened modeling material to ~~reduce~~ substantially eliminate the at least one surface effect…and to ~~reduce~~ substantially eliminate the porosity of the object at the object surface. For example, as shown in Image 6 from the Zinniel Declaration (reproduced below), when the object was subjected to the claimed vapor smoothing process, the at least one surface effect and the porosity at the object surface were each substantially eliminated.

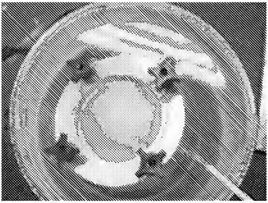

Image 6

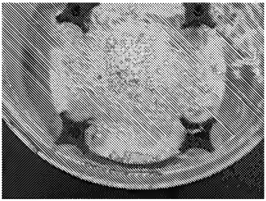

Image 7

In comparison, as shown in Image 7 from the Zinniel Declaration (reproduced above), when an identical object was subjected to hand sanding, the porosity of the object surface was not substantially eliminated, thereby allowing air and liquids to flow through the walls of the object.

Accordingly, amended independent claim 1 recites that the object, which is built using a fused deposition modeling technique, includes an object surface having at least one surface effect due to the fused deposition modeling technique, where the at least one surface effect extends substantially across an entirety of the object surface, and where the at least one surface effect is selected from the group consisting of a stair step effect, striation, a roughness due to errors in building the object, and a combination thereof. Claim 1 also recites that the object exhibits porosity due to the fused deposition modeling technique.

As illustrated in FIG. 1 of the present application (reproduced below), three-dimensional objects built using the fused deposition modeling technique exhibit one or more surface effects due to the fused deposition modeling technique, where the surface effect(s) may extend substantially across an entirety of the object surface (present application, FIG. 1;

page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20).

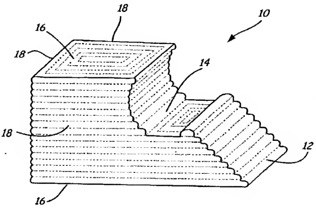

FIG. 1

For example, the object surface may exhibit stair-step effects created by the formation of successive layers, such as shown across angled surface 12 and curved surface 14 (present application, FIG. 1; page 2, lines 18-22; and page 6, lines 17-18). Additionally, the object surface may exhibit striation (e.g., texturing) created by formation of roads of the modeling material, such as shown across horizontal surfaces 16 and vertical surfaces 18 (present application, FIG. 1; page 2, lines 16-18; and page 6, line 20). Furthermore, the object surface may also exhibit roughness in one or more locations due to errors in building the three-dimensional object with the fused deposition modeling technique (present application, FIG. 1; page 2, lines 23-30; and page 6, line 20).

Pursuant to the method of claim 1, the three-dimensional object may be exposed to vapors of a solvent that transiently soften the modeling material at the object surface, and the softened modeling material may reflow to substantially eliminate the surface effect(s) to provides a smooth surface (present application, FIG. 2, page 8, lines 10-16). In addition, this substantially eliminates the porosity of the object at the object surface.

A. Three-Dimensional Objects Built with the Fused Deposition Modeling Technique are Different from Injection-Molded Articles

Neither Joseph nor Edmonds disclose or suggest the use of three-dimensional objects built using the fused deposition modeling technique, or the substantial elimination of surface effects due to the fused deposition modeling technique. Joseph are Edmond each directed to using vaporized solvents on injection-molded articles, such as to remove scratches, dents, blemishes, and small voids in plastic articles (e.g., for refurbishing such articles) (see e.g., Joseph, col. 4, lines 42-48; and Edmonds, col. 2, lines 43-51 and col. 3, lines 1-8). The Office Action contends that there is a one-to-one correlation between the surfaces of the articles smoothed in Joseph and Edmonds and the surfaces of three-dimensional objects built with the fused deposition modeling technique. This is an erroneous conclusion.

As illustrated in FIG. 1 of the present application, the surface effects due to the fused deposition modeling technique extend substantially across the entire surface of the three-dimensional object, including the bottom surface 16 (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20). This differs from surfaces merely having defects such as scratches, dents, blemishes, and small voids, or that merely require polishing. It is erroneous to conclude that the use of solvent vapors to smooth defects such as scratches, dents, blemishes, and small voids, or that merely require polishing is the same as the use of solvent vapors to substantially eliminate surface effect(s) due to the fused deposition modeling technique to provide a smooth surface and to substantially eliminate the porosity of the object at the object surface.

B. The Claimed Process Provides Unexpected Results

The substantial elimination of the at least one surface effect and the substantial elimination of the porosity at the object surface are also unexpected results for three-dimensional objects built with the fused deposition modeling technique. In fact, solvent vapors are not suitable for smoothing objects built from all forms of layered manufacturing rapid prototyping techniques. For example, as discussed in the August 5, 2008 Amendment, objects built with layered manufacturing rapid prototyping techniques such as the stereolithographic processes of Leyden use solvent vapors to remove excess resins (Leyden,

col. 6, lines 56-68; col. 9, lines 34-39; and col. 11, lines 35-44). These processes require subsequent smoothing processes, such as applying and curing an additional amount of the curable resin to fill in the surface discontinuities, to provide smooth surfaces (Leyden, col. 7, lines 1-15).

With respect to the substantial elimination of the porosity of the object at the object surface, the Office Action states that the reduction in porosity as claimed by Applicants is not an unexpected result sufficient to overcome the prior art. The Examiner bases this conclusion on two allegations: (1) that Joseph teaches the technique of filling voids with a solvent vapor process, and (2) that the Zinniel Declaration demonstrates that the admitted prior art as modified necessarily results in the reduced porosity.

With respect to the first allegation, the voids taught by Joseph are not porosity due to the fused deposition modeling technique. This is an erroneous conclusion made by the Examiner. The porosity due to the fused deposition modeling technique are pores entrained within the walls of the object. The mere fact that Joseph mentions that the solvent vapor process may be used to fill small voids does not teach or suggest to one skilled in the art that the claimed process in the present application may substantially eliminate porosity of the object at the object surface. In fact, when smoothing the surface of objects built with the fused deposition modeling technique to substantially eliminate porosity of the object at the object surface, voids and cavities that are intentionally formed during the build operation are desirably not filled during the claimed smoothing process.

Furthermore, the statement that the Zinniel Declaration demonstrates that the admitted prior art as modified necessarily results in a reduced porosity erroneously mischaracterizes the Zinniel Declaration. The Zinniel Declaration expressly states that sealing effect at the surface of the 3D object would be recognized by people skilled in the art of rapid prototyping/manufacturing processes *based on the teachings in U.S. Patent Application No. 10/511,784 (the current patent application)* (Zinniel Decl., ¶ 11) (emphasis added). The Zinniel Declaration does not demonstrate that the admitted prior art as modified necessarily results in substantially eliminating porosity of the object at the object surface.

Rather, the Zinniel Declaration demonstrates that the substantial elimination of porosity of the object at the object surface is an unexpected result sufficient to overcome the

prior art. As discussed above, the test results presented in the Zinniel Declaration show that, when subjected to the claimed process, the porosity of the object surface was substantially eliminated. In comparison, however, when the same object is merely subjected to abrasive smoothing (i.e., hand sanding), the porosity of the object surface was not substantially eliminated, thereby allowing air and liquids to flow through the walls of the object. Accordingly, the Examiner provides no sufficient basis that rebuts Applicants' assertion that the substantial elimination of the surface effect(s) and the substantial elimination of the porosity of the object at the object surface are unexpected results.

C. The Claimed Process Satisfies a Long-Felt Need for Smoothing Objects Built with the Fused Deposition Modeling Technique

Layered manufacturing rapid prototyping techniques have been around for over 20 years. In fact, the assignee of the present application filed a patent application in October, 1989 directed to the fused deposition modeling technique (issued as U.S. Patent No. 5,121,329), and the patent application for Batchelder, U.S. Patent No. 5,653,925 was filed in September, 1995. Due to their layer-by-layer nature, these layered manufacturing rapid prototyping techniques typically provide three-dimensional objects having surface effects, such as stair-step effects and striation effects, as discussed above.

While these surface effects typically do not affect the strengths of the three-dimensional objects, they do detract aesthetically (present application, page 2, lines 16-22). As such, there has been a long-felt need to eliminate the surface effects of three-dimensional objects built by layered manufacturing rapid prototyping techniques, including objects built by the fused deposition modeling technique. In fact, as discussed in the present application, attempts have been made to smooth the surfaces of such objects by manually trimming, machining, grinding, or buffing with cloths, sand paper, or solution-born abrasives (present application, page 3, line 6-17). However, such removal techniques also remove portions of the object surface, which can damage the fine features of the object, and are labor intensive.

Additionally, as discussed above, Leyden, which was filed in 1992, also discusses the need for smoothing object surfaces. However, the stereolithographic processes of Leyden are not suitable for the claimed vapor smoothing process of the present application (Leyden, col.

6, lines 56-68; col. 9, lines 34-39; and col. 11, lines 35-44). As such, the Leyden processes require a smoothing process, such as applying and curing an additional amount of the curable resin to fill in the surface discontinuities, to provide smooth surfaces (Leyden, col. 7, lines 1-15).

Despite the extended time period in which the fused deposition modeling technique has existed, Applicants assert that they are the first to substantially eliminate surface effect(s) in objects built with the fused deposition modeling technique with the use of the claimed vapor smoothing process. If the claimed process were otherwise obvious to one skilled in the art, as the Examiner erroneously contends, then Applicants question why the claimed process did not show up in the field prior to Applicants' development, despite the long-felt need for such low labor-intensive techniques. Accordingly, in addition to the reasons discussed above, Applicants assert that the processes recited in claims 1, 21, and 43 of the present application present a solution to a long-felt need for efficiently smoothing the surfaces of objects built with the fused deposition modeling technique.

D. The Claimed Process Satisfies a Long-Felt Need for Substantially Eliminating Surface Porosity in Objects Built with the Fused Deposition Modeling Technique

Objects built with the fused deposition modeling technique are porous due to the build technique (Zinniel Decl., ¶ 10). The pores are created to provide a cushion in the build parameters when depositing materials to maintain dimensional accuracy of the objects (Zinniel Decl., ¶ 10). This is discussed in Batchelder, U.S. Patent No. 5,653,925, filed in September, 1995 (Zinniel Decl., ¶ 10).

It is known to those skilled in the art that objectf built with the fused deposition modeling technique are suitable for use as real, usable parts due to the strengths of the thermoplastic modeling materials. However, such objects are also porous, which allows fluids to pass through the walls of the objects, thereby potentially reducing the functionality of the objects to retain gases and liquids. This is demonstrated in the tests discussed in the Zinniel Declaration. For example, such objects may be less desirable for use as liquid vessels (e.g., a coffee cup) due to the porosity.

As such, there has been a long-felt need to eliminate the porosity of three-dimensional objects built by the fused deposition modeling technique, which may create water-tight objects that can withstand pressure buildup (see e.g., the Declaration of Fransisco Medina, submitted with the March 27, 2009 Amendment). Yet, despite this long-felt need, Applicants assert that they are the first to substantially eliminate the porosity in the objects at the object surfaces with the use of the claimed vapor smoothing process. If the claimed process were otherwise obvious to one skilled in the art, as the Examiner erroneously contends, then Applicants question why the claimed process did not show up in the field prior to Applicants' development, despite the long-felt need for sealed-walls objects.

Furthermore, the plastic articles that are smoothed pursuant to Joseph and Edmonds are typically built from an injection molding or similar technique, and do not exhibit such porosity issues. Thus, the plastic articles do not exhibit any reduction in surface porosity. Joseph and Edmonds do not recognize the issue that is presented by objects built with the fused deposition modeling technique. Accordingly, this combination of exposing the object to solvent vapors/reflowing the softened modeling material with the use of an object built with a fused deposition modeling technique provides substantial porosity elimination characteristics that are not present in, nor recognized by, the teachings of the cited references. Accordingly, in addition to the reasons discussed above, Applicants assert that the processes recited in claims 1, 21, and 43 of the present application also present a solution to a long-felt need for substantially eliminating porosity in objects built with the fused deposition modeling technique, at the object surfaces.

Accordingly, the cited references, taken alone or in combination, do not teach or render obvious the elements of claims 1, 21, and 43. As such, claims 1, 21, and 43 are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph, Edmonds, and/or Batchelder, and are allowable. Additionally, dependent claims 3, 8, 10, 11, 18, 19, 22, 27, 28, 33, 45, and 47-49, which depend from claims 1, 21, and 43 are also not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph and/or Edmonds, and are separately allowable.

Moreover, Dahlin, Leyden, and Gessner also do not teach or render obvious the elements of claims 1, 21, and 43. As such, independent claims 1, 21, and 43, and dependent claims 4, 5, 18, 20, 23, 46, and 48, which depend from claims 1, 21, and 43, are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph/Edmonds, Batchelder, Dahlin, Leyden, and/or Gessner, and are allowable.

CONCLUSION

Applicants respectfully submit that independent claims 1, 21, and 43 are in form for allowance. Applicants also submit that dependent claims 3-5, 8, 10, 11, 18, 20, 22, 23, 27, 28, 33, and 45-49 are in form for allowance as well due to their dependent nature. Reconsideration and allowance of claims 1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49 are respectfully submitted.

The foregoing remarks are intended to assist the Office in examining the application and in the course of explanation may employ shortened or more specific or variant descriptions of some of the claim language. Such descriptions are not intended to limit the scope of the claims; the actual claim language should be considered in each case. Furthermore, the remarks are not to be considered exhaustive of the facets of the invention which are rendered patentable, being only examples of certain advantageous features and differences, which Applicants' attorney chooses to mention at this time. For the foregoing reasons, Applicants reserve the right to submit additional evidence showing the distinction between Applicants' invention to be unobvious in view of the prior art.

Furthermore, in commenting on the references and in order to facilitate a better understanding of the differences that are expressed in the claims, certain details of distinction between the same and the present invention have been mentioned, even though such differences do not appear in all of the claims. It is not intended by mentioning any such unclaimed distinctions to create any implied limitations in the claims.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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